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Research Article

Effect of 4-Weeks Hypoxic Training on Some Physiological and Biochemical Parameters of Athletes -

Nader Ismail Halawa*

Sports Training Department, Faculty of Physical Education and Sport

***Address for Correspondence:** Nader Ismail Halawa, Sports Training Department, Faculty of Physical Education and Sport, Al-Aqsa University, Gaza, Palestine, Tel: +009-725-994-12252; E-mail: nader800sm@hotmail.com

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ABSTRACT

This study aims at exploring the effect of a 4-week hypoxic training on some physiological and biochemical parameters in the 400-m competing athletes of the Palestinian athletics team. Twelve trained male athletes were divided into two groups, normoxic training (n = 6) and hypoxic training (n = 6) for residing at sea-level. The training period was 90min, 3 days per week for 4 weeks. Therefore, physiological measurements showed (Vital Capacity (VC), Maximal Oxygen Consumption (VO2max) and Heart-Rate (HR)); Biochemical measurements (Erythropoietin (EPO), Hemoglobin (Hb), Hematocrit (Hct) and Partial Oxygen Pressure PO2); the numerical level of running 400m.

Haematological parameters EPO, Hb, Hct and PO2 observed a significantly improved. Also, physiological measurements showed a significant changed in VO2max, vital capacity and heart rate as well as pulse-rest (HR rest), pulse-effort (HR effort) of hypoxic training group. Based on these results, our study indicated hypoxic training had a positive effect when the data of both groups were combined.

Keywords: Erythropoietin; Hypoxic training; Hemoglobin; Hematocrit; Heart-rate

INTRODUCTION

Hypoxic training is a widely used method in various training programs, which involves training for certain periods in chosen hypobaric or normobaric hypoxia environment [1]. The examining effects on aerobic metabolism and energetic performance in cycling athletes after 2 weeks as described above in a multistep hypobaric hypoxia. Clearly the environment positively affected aerobic metabolism and showed effect on energy production as well as performance where improved VO2max as found by (Kim, An, Choi, & Kim, 2017) [2].

Based on published research, the evaluate effects of six-weeks of a training for six-weeks of hypoxic training on exercise performance in moderately trained competitive swimmers. The results showed that the hypoxic training as proposed is effective for increasing muscular strength and endurance potential in moderately trained. Various hypoxic training methods would enhance greater performance improvements as compared to concurrent and parallel similar training at sea-level [3].

[4] Study effect of intermittent normobaric hypoxic exposure through 3-weeks at rest on haematological, physiological, and performance parameters in multi-sport athletes, however, the performance enhancement parallel to substantial increases in hematocrit and reticulocytes. The regular and short exposure to hypoxia inflicted physiological responses that develop from physical performance, lead to increased red blood cells and increase hemoglobin. Hypoxic training improves aerobic endurance and anaerobic tolerance for players [5]. Principally, Intermittent Hypoxic Training (IHT) may raise aerobic capacity and sport performance which is most often evaluated by maximal oxygen uptake (VO2max), as well as increase endurance performance at sea level by several adaptive changes [6]. However, the realization of a training program together with hypoxic stimulus generates stress on the athlete's body producing adaptations that increase the athlete's performance. This increase is most likely due to prevalent biochemical and structural changes in the musculoskeletal system that improve the oxidative process [7,8].

Hypoxic exercises and their effect on metabolic changes in men, aimed at identifying the metabolic and cardiac changes resulting from the use of hypoxic training in healthy men. The experimental method was used on a vertical sample of 32 of athlete men. The results demonstrated no change in the ratio of folic acid to red blood cells, less lactic acid concentration during training [9]. The effects of more frequent training in normobaric hypoxia on aerobic capacity in basketball players [6]. There are two principal intermittent hypoxic training methods: intermittent hypoxic exposition IHE in which athletes are in a room with hypoxic ambient air or with a lower oxygen concentration than in normal conditions and IHT which can be conducted in normobaric or hypobaric ambient air and in which the athlete carries out continuous or interval training in hypoxic air ambient [10].

IHT has caught increasing attention in the last years, thus the physiological effects of IHT were tested in a chosen hypobaric or normobaric hypoxia environment examined systemic aspects by examining Maximal Oxygen Consumption (VO2max) and Oxygen Consumption (VO2) under submaximal exercise based on changes in physiological indicators that inflict oxygen delivery capacity, which include Red Blood Cells (RBC), Hemoglobin (Hb), Reticulocyte (Ret), and Erythropoietin (EPO) [11]. On the other hand, the frequent hypoxic training for 90 minutes three times a week for 3 weeks is enough to stimulate secretion of erythropoietin and increase red blood cells, the results showed a marked increase in Ret count (180%), RBCs (7%), Hb (13%) and Hct (6%) [12].

Careful review of the literature spotted no relevant work on the Palestinian territories and that there is a need to shed light on this important approach to study its effect and explore the results and this made the impetus for the current study to test the effect of hypoxic training on some physiological and biochemical variables among the 400m players of the Palestinian athletics team.

MATERIAL AND METHODS

Participants

The participants were 16 male players of the Palestinian athletics team for favor of post measurement. Four players were randomly chosen to conduct the survey. The major experiment was conducted on 12 remaining members of the sample. The characteristics of the participants are shown in table 1.

Table 1: The characteristics of the participants (x ± SD).

Items	Normoxic Athlete	Hypoxic Athlete
Length (cm)	180.2 ± 2.2	181.2 ± 1.3
Weight (Kg)	74.2 ± 3.5	74.8 ± 3.0
Age (yr)	22.2 ± 1.1	22.1 ± 1.5

Homogeneity

A homogeneity was found between the basic research sample of

(12) players from the research population in some variables, in which may affect the results.

Methodology

The participants were divided into two groups assigned into a normoxic training group (n = 6) and hypoxic training group (n = 6) in which pre and post measurements were implemented to be appropriate with this research.

Blood samples collection

A medical technician collected and analyzed the blood samples with appropriate tools and measured the concentration of erythropoietin and its activity to assess the value of hematocrit and hemoglobin in the blood as well as the physiological effects of normoxic and hypoxic environment which inflict a vital capacity VO2max indicative of pulse-rest and pulse-effort. Blood samples were collected each week (W1 to W4).

Training hypoxia program

The tests at sea level were being made before and after training. Simultaneously, the research was conducted as follows: preparatory period 2 weeks of general conditioning, then a 90-minute training three sessions a 4-week training every other day by the training sessions under each environmental conditions and finally after-test sessions. Figure 1 illustrated the training program of hypoxic and normoxic groups with pre and post measurements. The daily training was 90 minute. Pre- and post-measurement: of physiological and biochemical variables during a step-load maximal exercise for comparing the efficiency of training [13].

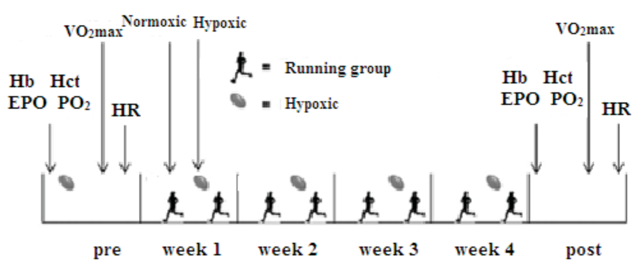

Figure 1: Timeline of Training program of hypoxic and normoxic groups with pre and post measurements

Participants performed five kinds of training in 90 min sessions: warm-up, continuous training, interval training, elastic resistance training, and cool-down. The training frequency was 90 min, 3 days a week for 4 weeks. Warm-up and cool-down were set at 50% HRmax for each participant for 5 min and then increased by 10% HRmax every 5 min and performed for 10 min. The continuous training sessions consisted of 30 min of continuous running exercise that corresponded to 80% of the HRmax. The running velocity was changed using a heart rate monitor to match 80% HRmax. The measured running load with 90% HRmax during maximal running exercise at each environmental condition on the third pre-test day was set as the exercise intensity during interval training session

Optimization of different hypoxic doses

Twelve runner athletes, two groups triathletes divided into two group assigned into a normoxic training group (n = 6) and hypoxic training group (n = 6). The pre and post measurement, in order to be appropriate with the nature of this research. All were professional athletes in the final preparations for major events. The athletes were exposed to hypoxic training alternated by normoxic air also for 90 minutes a day for a total of 12 days.

All athletes performance were assessed in the form of specific field time trials in their sport, decided by the athletes and their coach and hematological testing (Hb, Hct, EPO and PO2) before, and after the training. During the period athletes kept a record of subjective perception in regard to muscle soreness, fatigue, sleep and performance [14].

On the first test day, blood samples were collected between 7:00 and 8:30 am after a day of fasting for analysis of blood variables (EPO, Hb, Hct and PO2) related to muscular function at sea-level in Gaza. Henceforth, the athletes were allowed to eat and relax for two hours, anaerobic power and muscular function were measured at normoxic condition and had a physiological measurements (pulse-rest, pulse-effort, maximal oxygen consumption VO2max and vital capacity) were measured using a graded exercise testing, short continuous protocol 1.5 hr/day for evaluation of aerobic exercise capacity at normoxic condition. On the final test day for 4 weeks, all participants measured the exercise load at each condition (normoxic: control group and hypoxic group) using a graded exercise testing by, 400m running performance at sea-level in Gaza, thus post physiological and biochemical measurement as well as pre-tests.

RESULTS

The average of all measurements of the training data for aerobic exercise capacity in both groups is as shown as in table 2. Most measurements were performed twice and the mean evaluated for physiological and oxygen parameters in skeletal muscle during 90 minutes of maximal exercise running of 400m, aerobic exercise performing before and after the training period consists of aerobic continuous exercise that sets a maximum heart rate during 90 minutes and anaerobic exercise [13]. These results indicate statistically significant differences in physiological variables vital capacity, VO2max and heart rate of the players. Marked changes were noted in the hypoxic training group as compared to the normoxic training group [15]. Also, hematological parameters data before and after training are shown in table 3, observed that 1.5 hour of passive hypoxic exposure was sufficient to obtain significant increases. However, the results showed a significantly improved in plasma concentration and other blood parameters. Performance of the players of 400m improved by 2.9% after 12 days of hypoxic training, Hb by 5.5%, Hct by 5.1%, EPO by 10.2% and the partial pressure of oxygen PO2 decreases by 4.3%.

Table 2: Pre- and post-training data for physiological variables of the participants (x ± SD).

Categories	Hypoxic Athlete		Normoxic Athlete	
	Pre	Post	Pre	Post
HRrest (bpm)	65 ± 1.9	64 ± 2.2	64 ± 3.0	61 ± 2.4
HReffort (bpm)	184 ± 2.2	184 ± 2.8	183 ± 2.6	178 ± 2.0
VO2max (mL/kg/min)	48.2 ± 1.5	49.8 ± 2.1	49.5 ± 1.0	51.9 ± 1.8
VC (L)	3.8 ± 0.2	3.9 ± 0.3	3.9 ± 0.3	4.4 ± 0.4

Table 3: Pre- and post-training data for biochemical variables of the participants (x ± SD).

Categories	Hypoxic Athlete		Normoxic Athlete	
	Pre	Post	Pre	Post
Erythropoietin (mU/ml)	14.9 ± 1.1	15.3 ± 1.5	14.7 ± 1.5	16.2 ± 1.8
Hemoglobin (g/dl)	14.9 ± 1.4	15.0 ± 2.1	14.5 ± 1.7	15.3 ± 1.3
Hematocrit (%)	34.6 ± 2.5	35.7 ± 2.5	35.2 ± 2.5	38.9 ± 2.3
PO2 (mmHg)	76.8 ± 5.0	76.6 ± 4.5	78.2 ± 4.8	75.0 ± 3.9
400 m (s)	50.3 ± 3.0	50.0 ± 2.5	50.5 ± 2.2	49.1 ± 2.0

DISCUSSION

In this research have been measured some physiological and biochemical parameters threshold, determined at a constant concentration of (EPO, Hb, Hct and PO2). In addition, measured (VO2max, pulse-rest, pulse-effort and vital capacity). Therefore, twelve obese men aging around 20 years in a normoxic training group (n = 6) and hypoxic training group (n = 6) performed training session (running exercise at a total duration of 90 minutes 3 days per week, for 4 weeks).

Reducing the amount of oxygen available for delivery to exercising tissues [16]. The reduction in inspired PO2 that occurs with exposure to hypoxia is the stimulus for increased EPO production [17]. Briefly, blood parameters such as Hemoglobin (Hb) content appear to be major factors contributing to increases in maximal oxygen uptake VO2max observed after altitude training [18]. The results showed improvements in VO2max (4.8%) in the amount of energy produced by cellular respiration. Thus, an increase in vital capacity will increase energy production. This is beneficial to the performance of an athlete. During exercise, there is an increased need for oxygen by an athlete's cells and muscles. A greater vital capacity (+12.8%) ensures that extra oxygen is delivered to the body and the excess carbon dioxide is exported from the body. As results, we found that 4 weeks of aerobic exercise training in the hypoxic conditions was more effective in improvement of VO2max value and hematological parameters of hypoxia athlete group compared to the normoxic training group. It was evaluated for physiological and oxygen parameters in skeletal muscle during 90 minutes of maximal running exercise, aerobic exercise performing before and after 4 weeks of training consist of aerobic continuous exercise that sets a maximum heart rate during 90 minutes. HR significant improved by decreased HReffort 5 Beats per Minute (bpm) from 183 bpm to 178 bpm for hypoxia group, thus, HReffort changed by 2.8%.

The present study makes a direct evaluation of such physiological and biochemical changes, which may be attributable to the 4-week hypoxia training, which resulted in increased activation and ventilation. Thus, results were due to the positive changes improving aerobic capacity at sea level in the study participants.

Running performance improved during incremental step exercise, including changes of HR profile power (–2.8%), VO2max (+4.8%) and VC (+12.8%) in peak aerobic power, and in blood variables Hb by (+5.5%), Hct by (+5.1%), EPO by (+10.2%) and PO2 by (-4.3%) compared to control measured 12 days post-intervention.

Statistical analysis

The obtained data were analyzed statistically using SPSS 23.0 (IBM Corp., Armonk, USA. Basic descriptive statistics were calculated, and all variables were examined for normal distribution. Data are presented as the mean ± SD. (ANOVA) was used to evaluate within-participant differences between environmental conditions. The level of significance was set a priori at 0.05.

CONCLUSION

The present study showed that exercise training at hypoxic conditions had a positive effect and efficiency on physiological and hematological parameters in obese the players of 400 m in the Palestinian athletics team compared with normoxic running training performance at sea-level. However, the results showed a significant change in physiological parameters and blood analysis.

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